Date: July 2004

**Specification for Battery Back-up System**
**For Traffic Signals utilizing**
**Light Emitting Diodes (LED) Traffic Signal Modules:**

## GENERAL

This specification establishes the minimum requirements for a complete emergency battery backup system for use with Light Emitting Diode (LED) Traffic Signal Modules. The Battery Backup System (BBS) shall include, but not be limited to the following: Inverter/Charger, Power Transfer Relay, batteries, a separate manually operated non-electronic Bypass Switch (See Figure 1 – BBS Block Diagram) and all necessary hardware and interconnect wiring. The BBS shall provide reliable emergency power to a traffic signal system (Vehicle and Pedestrian Traffic) in the event of a power failure or interruption.

The BBS shall be capable of providing power for full run-time operation for an "LED-only" intersection (all colors: red, yellow, green and pedestrian heads) or flashing mode operation for an intersection using Red LED's.

The BBS shall be designed for outdoor applications, in accordance with the Caltrans Transportation Electrical Equipment Specifications (TEES), dated August 16, 2002, Chapter 1 requirements.

## 1. OPERATION

1.1
The BBS shall provide a minimum two (2) hours of full run-time operation for an "LED-only" intersection (minimum 700W/1000VA active output capacity, with 80% minimum inverter efficiency).

1.2
The maximum transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from batteries, shall be 65 milliseconds. The same maximum allowable transfer time shall also apply when switching from inverter line voltage to utility line voltage.

1.3
The BBS shall provide the user with 3-sets of normally open (NO) and normally closed (NC) single-pole double-throw (SPDT) dry relay contact closures, available on a panel-mounted terminal block, rated at a minimum 120V/1A, and labeled so as to identify each contact. For typical configuration, see Figure 3(b).

1.3.1
The first set of NO and NC contact closures shall be energized whenever the unit switches to battery power. Contact shall be labeled or marked "On Batt."

1.3.2
The second set of NO and NC contact closures shall be energized whenever the battery approaches approximately 40% of remaining useful capacity. Contact shall be labeled or marked "Low Batt."

1.3.3
The third set of NO and NC contact closures shall be energized two hours after the unit switches to battery power. Contact shall be labeled or marked "Timer."

1.3.4
Relay contact activation shall be annunciated on the front panel via a visual indication. This can be either discreet LED, or part of LCD screen, etc.

1.4
Operating temperature for both the inverter/charger, power transfer relay and manual bypass switch shall be –37 °C to +74 °C.

1.5
Both the Power Transfer Relay and Manual Bypass Switch shall be rated at 240VAC/30 amps, minimum.

1.6
The BBS shall use a temperature-compensated battery charging system. The charging system shall compensate over a range of 2.5 – 4.0 mV/ °C per cell.

1.6.1
The temperature sensor shall be external to the inverter/charger unit. The temperature sensor shall come with 3 meters (9'10") of wire.

1.7
Batteries shall not be recharged when battery temperature exceeds 50 °C ± 3 °C.

1.8
BBS shall bypass the utility line power whenever the utility line voltage is outside of the following voltage range: 100VAC to 130VAC (± 2VAC).

1.9
When utilizing battery power, the BBS output voltage shall be between 110 VAC and 125 VAC, pure sine wave output, ≤ 3% THD, 60Hz ± 3Hz.

1.10
BBS shall be compatible with Caltrans Model 332A Cabinets, Model 170E Controllers, Model 2070 Controllers and cabinet components for full time operation.

1.11
In cases of low (below 98VAC) or absent utility line power, when the utility line power has been restored at above 105 VAC ± 2 VAC for more than 30 seconds, the BBS shall transfer from battery backed inverter mode back to utility line mode.

1.12
In cases of high utility line power (above 132VAC), when the utility line power has been restored at below 125VAC ± 2 VAC for more than 30 seconds, the BBS shall transfer from battery backed inverter mode back to utility line mode.

1.13
BBS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service.

1.14
In the event of inverter/charger failure, battery failure or complete battery discharge, the power transfer relay shall revert to the NC (and de-energized) state, where utility line power is connected to the cabinet.

1.15
Recharge time for the battery, from "protective low-cutoff" to 80% or more of full battery charge capacity, shall not exceed twenty (20) hours.

## 2. MOUNTING/ CONFIGURATION

### 2.1 GENERAL

**NOTE: All references made to EIA rail or EIA 19" (482.6mm) rack shall conform to Electronic Industries Standards EIA-310-B, Racks, Panels, and Associated Equipment, with 10-32 "Universal Spacing" threaded holes.**

2.1.1
Inverter/Charger Unit shall be shelf-mounted or rack-mounted on a standard EIA 19" rack. If designed to be shelf mounted inside the 332A Cabinet, the shelf shall be provided.

2.1.2
Power Transfer Relay and Manual Bypass Switch shall be mounted on EIA rail.

2.1.3
All interconnect wiring shall be provided between Power Transfer Relay, Bypass Switch and Cabinet Terminal Service Block and shall be no less than 3 meters (9'10") of UL Style 1015 CSA TEW with the following characteristics:

| | |
|---|---|
| AWG Rating: | 10 AWG |
| Stranding: | 105 strands of 30 AWG tinned copper |
| Rating: | 600 V, 105 °C, PVC Insulation |

2.1.4
Relay contact wiring provided for each set of NO/NC relay contact closure terminals shall be 3 meters (9’10”) of UL Style 1015 CSA TEW 18 AWG wire, same ratings as above, except 16 strands of 30 AWG tinned copper.

2.1.5
Figure 4 provides clarification as to how BBS Power Transfer Relay and Manual Bypass Switch are interconnected with Model 332A Cabinets in order to ensure interchangeability between all BBS manufacturers.

2.1.6
All necessary hardware for mounting (shelf angles, rack, etc) shall be included in the bid price of the BBS. A minimum of 6 bolts/fasteners shall be used to secure swing-trays to the 332A Cabinet standard EIA 19” (482.6mm) rack. All bolts/fasteners and washers shall meet the following requirements:

Screw type: Pan Head Phillips machine screw
Size and Thread pitch: 10-32
Material: 18-8 stainless steel (Type 316 stainless steel is acceptable as an alternate)
Washer: Use one flat washer (18-8 stainless steel) under the head of each 10-32 screw (provided that the screws are properly tightened, lock washers are unnecessary.)
Number of screws per hinge bracket: Minimum of six (6) screws per hinge bracket spaced evenly along bracket, with one screw near each end.

2.1.7
There shall be two (2) basic BBS mounting options:

(1) Internal Mounted Option – The entire BBS, including batteries is installed inside the 332A Cabinet.
(2) External Cabinet Option with two configurations.
Configuration 1 – The BBS (Inverter/Charger, Bypass Switch and Transfer Relay only) installed inside the 332A Cabinet, with the batteries installed in the externally mounted cabinet.
Configuration 2 – The entire BBS, including batteries, installed inside the externally mounted cabinet.

## 2.2 INTERNAL MOUNTED OPTION

2.2.1
Complete BBS, including batteries, shall fit inside a typical, fully equipped Caltrans Model 332A Cabinet that includes one Model 170E or 2070 Controller. This configuration shall also fit inside the External Cabinet.

2.2.2
Mounting method shall be shelf-mount, rack-mount, swing-tray mount or combination of either. Front-mounted available rack space is a maximum of 152.4mm (6”). For additional space, see Figure 2 – BBS Mounting Diagram

2.2.3
Batteries mounted below the controller shelf shall be swing-tray mounted. Batteries may be shelf mounted in area behind controller so long as shelf and batteries do not interfere with controller unit and C1 plug.

2.2.4
Battery swing-tray hinge bracket shall mount on right hand side of EIA rack in rear of cabinet.

## 2.3 EXTERNAL CABINET OPTION

2.3.1
The External Cabinet shall be used for housing batteries and/or BBS, which includes inverter/charger unit, power transfer relay, manually operated bypass switch, any other control panels, and all wiring and harnesses.

2.3.2
The same Inverter/Charger, Power Transfer Relay and manually operated Bypass Switch that fits inside a typical fully equipped Caltrans Model 332A Cabinet shall also be able to fit inside the externally mounted cabinet.

2.3.3
The External Cabinet shall be a NEMA 3R rated cabinet mounted to the side of the Model 332 Cabinet (see Figure 5 for details). This external cabinet shall conform to TEES, August 16, 2002 Chapter 7, Section 2-Housings for the construction and finish of the cabinet. The specific finish of the external cabinet shall be anodic as per TEES 7.2.2.3.1. Anti-Graffiti paint shall not be used.

2.3.4
The external cabinet shall mount to the Model 332 Cabinet with a minimum of eight bolts. Figure 5 shows the typical mounting location of the external cabinet.

2.3.5
The specific dimensions and details of the external battery cabinet shall be as shown in Figure 6 through 8.

2.3.6
Four shelves shall be provided. There shall be a minimum of 304.8mm (12”) clearance between shelves. Each shelf shall be a minimum of 263.65mm (10.38”) X 635.0mm (25”), and capable of supporting a minimum of 57kg (125 lbs.). Shelf edges shall be turned down on all four sides for support and to provide a flat top surface. Shelves shall be predrilled with EIA rail mounting holes.

2.3.7
The bottom shelf shall be removable.

2.3.8
The external cabinet shall be ventilated through the use of louvered vents, filter, and one thermostatically controlled fan as per TEES Chapter 7 Section 2-Housings.

2.3.9
External cabinet fan shall be AC operated from the same line output of the Manual Bypass Switch that supplies power to the 332 Cabinet. A 2-position terminal block shall be provided on the fan panel, along with 3 meters of connected hookup wire.

2.3.10
The door shall be attached to the cabinet through the use of either a continuous stainless steel piano hinge or four, two-bolts per leaf, hinges as per TEES Chapter 7 Section 2. The door shall use a padlock clasp or latch and lock mechanisms as described in the TEES, in order to lock the door.

2.3.11
The external cabinet shall come provided with all bolts, washers, nuts and cabinet-cabinet coupler fittings provided, necessary for mounting the external cabinet to the 332A Cabinet.

2.3.12
Fasteners shall meet the following requirements:
(Total of 8 bolts per cabinet with 2 flat washers per bolt and 1 K-lock nut per bolt)

Cabinet mounting bolts shall be:

18-8 Stainless Steel Hex Head (Fully Threaded)

3/8" – 16 X 1"

Washers shall be:

Designed for 3/8" bolt

18-8 Stainless Steel 1" OD round flat type

K-lock washer shall be:

18-8 Stainless Steel, Hex Nut Assembled with Free-Spinning Tooth Washer

3/8" – 16 Screw size

2.3.13
External Cabinet to 332A Cabinet couplings shall provide a conduit for power connections between the 332A Cabinet and External Cabinet. The couplings shall consist of three parts and meet the following requirements:

2" Nylon Insulated, Steel Chase Nipple, T & B 1947 or equivalent

2" Sealing, Steel Locknut, T & B 146SL or equivalent

2" Nylon Insulated, Steel Bushing, T & B 1227 or equivalent

2.3.14
Two EIA angle rails, per Detail C, Figure 8, along with all necessary mounting hardware (4 sets of 10-32 bolts and nuts with captive washers) shall be provided with the external cabinet (not installed). Rails shall be symmetric to allow for installation on either right or left sides of the cabinet. Mounting holes and bracket shall allow for EIA rail installation at any location in the

external cabinet. The EIA mounting angle nominal thickness shall be either 0.1345 inch (3.4163mm) plated steel or 0.105 inch (2.667mm) stainless steel.

2.3.15
EIA rail mounting bracket shall be of continuous, one-piece design bolted into the cabinet to provide adequate support for rail-mounted equipment. See Detail B, Figure 7.

2.3.16
Pressed in, flush-head threaded screw posts shall be inserted into the front face of the cabinet enclosure top sill. These threaded posts shall be used to mount both the fan panel and the EIA rail-mounting bracket. The screw posts shall be #10-32 thread size PEM Stud, part number FHA-032-10 or equivalent. Refer to Figure 6, front views for mounting detail.

## 3. MAINTENANCE, DISPLAYS, CONTROLS AND DIAGNOSTICS

3.1
The BBS shall include a display and /or meter to indicate current battery charge status and conditions.

3.1.1
The BBS shall provide voltmeter standard probe input-jacks (+) and (-) to read the exact battery voltage drop at the inverter input.

3.1.2
The BBS shall include a 0 to 100% battery capacity LED indicator.

3.2
The BBS shall have lightning surge protection compliant with IEEE/ANSI C.62.41.

3.3
The BBS shall be equipped with an integral system to prevent battery from destructive discharge and overcharge.

3.4
The BBS and batteries shall be easily replaced with all needed hardware and shall not require any special tools for installation.

3.5
The BBS shall include a front-panel event counter display to indicate the number of times the BBS was activated and a front-panel hour meter to display the total number of hours the unit has operated on battery power. Both meters shall have push button resets.

3.6
Manufacturer shall include a set of equipment lists, operation and maintenance manuals, and board-level schematic and wiring diagrams of the BBS, and the battery data sheets. Manual shall conform to TEES August 16, 2002, Chapter 1, Section 1.2.4.2.

## 4. BATTERY SYSTEM

4.1
Individual batteries shall be:

Voltage rating: 12V type
Amp-hour rating: 80 amp-hour maximum
Group size: 24 maximum
Batteries shall be easily replaced and commercially available off the shelf.

4.2
Batteries used for BBS shall consist of 4 to 8 batteries with a cumulative minimum rated capacity of 240 amp-hours.

4.3
Batteries shall be deep cycle, sealed prismatic lead-calcium based AGM/VRLA (Absorbed Glass Mat/ Valve Regulated Lead Acid).

4.4
Batteries shall be certified by the manufacturer to operate over a temperature range of – 25 °C to +74 °C.

4.5
The batteries shall be provided with appropriate interconnect wiring and corrosion-resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.

4.6
Batteries shall indicate maximum recharge data and recharging cycles.

### 4.7 BATTERY HARNESS

4.7.1
Battery interconnect wiring shall be via two-part modular harness.

4.7.2
Part I shall be equipped with red (+) and black (-) 30.48 cm (12”) cabling that can be permanently connected to the positive and negative posts of each battery. Each red and black pair shall be terminated into an Anderson style Power Pole connector or equivalent.

4.7.3
Part II shall be equipped with the mating Power Pole style connector for the batteries and a single, insulated Power Pole style connection to the inverter/charger unit. Harness shall be fully insulated and constructed to allow batteries to be quickly and easily connected in any order to ensure proper polarity and circuit configuration.

4.7.4
Power Pole connectors may be either one-piece or two-piece. If a two-piece connector is used, a locking pin shall be used to prevent the connectors from separating.

4.7.5
The length of the battery interconnect harness (Part II) shall be a minimum of 152.4 cm (60”) from the Inverter/Charger plug to the first battery in the string. The lateral length of the harness between battery connectors shall be a minimum of 30.48 cm (12”).

4.7.6
All battery interconnect harness wiring shall be UL Style 1015 CSA TEW or Welding Style Cable or equivalent, all of proper gauge with respect to design current and with sufficient strand count for flexibility and ease of handling.

4.7.7
Battery terminals shall be covered and insulated with molded boots so as to prevent accidental shorting.

## 5. QUALITY ASSURANCE

5.1
Each BBS shall be manufactured in accordance with a manufacturer Quality Assurance (QA) program. The QA program shall include two Quality Assurance procedures: (1) Design QA (see 5.4 below) and (2) Production QA. The Production QA shall include statistically controlled routine tests to ensure minimum performance levels of BBS units built to meet this specification and a documented process of how problems are to be resolved.

5.2
QA process and test results documentation shall be kept on file for a minimum period of seven years.

5.3
Battery Backup System designs not satisfying Design QA Testing and Production QA Testing requirements shall not be labeled, advertised, or sold as conforming to this specification.

### 5.4 DESIGN QUALIFICATION TESTING

5.4.1
The manufacturer, or an independent testing lab hired by the manufacturer, shall perform Design Qualification Testing on new BBS system(s) offered, and when any major design change has been implemented on an existing design. A major design change is defined as any modification, either material, electrical, physical or theoretical, that changes any performance characteristics of the system, or results in a different circuit configuration. Where a dispute arises in determining if a system is a new design or if the system has had a major design change, the State will make the final determination if Design Qualification Testing is required prior to production consideration.

5.4.2
A quantity of two units for each design shall be submitted for Design Qualification Testing.

5.4.2.1
Test units shall be submitted to Caltrans TransLab, Electrical Testing Branch after the manufacturer's testing is complete.

5.4.2.2
Manufacturer's testing data shall be submitted with test units for Caltrans verification Design Qualification Testing.

5.4.3 Burn In.
The sample systems shall be energized for a minimum of 5 hours, with full load of 700 watts, at temperatures of +74 °C and –37 °C, excluding batteries, before performing any design qualification testing.

5.4.4
Any failure of the BBS, which renders the unit non-compliant with the specification after burn-in, shall be cause for rejection.

5.4.5
For Design Qualification Testing, all specifications will be measured including, but not limited to:

5.4.5.1
Run time while in battery backup mode, at full load.

5.4.5.2
Proper operation of all relay contact closures ("On-Batt", "Low-Batt" and "Timer").

5.4.5.3
Inverter output voltage, frequency, harmonic distortion, and efficiency, when in battery backed inverter mode.

5.4.5.4
All power transfer voltage levels. See BBS Spec 1.8, 1.11 and 1.12.

5.4.5.5
Power transfer time from loss of utility line voltage to stabilized inverter line voltage from batteries.

5.4.5.6
Backfeed voltage to utility when in battery backed inverter mode.

5.4.5.7
IEEE/ANSI C.62.41 compliance.

5.4.5.8
Battery charging time.

5.4.5.9
Event counter and runtime meter accuracy.

## 5.5 PRODUCTION QUALITY CONTROL TESTING

5.5.1
Production Quality Control tests shall consist of all of the above listed tests and shall be performed on each new system prior to shipment. Failure to meet requirements of any of these tests shall be cause for rejection. The manufacturer shall retain test results for seven years.
5.5.2
Each BBS shall be given a minimum 100-hour burn-in period to eliminate any premature failures.

5.5.3
Each system shall be visually inspected for any exterior physical damage or assembly anomalies. Any defects shall be cause for rejection.

## 5.6 CALTRANS QUALITY ASSURANCE TESTING

5.6.1
Caltrans will perform random sample testing on all shipments, consistent with ANSI/ASQC Z1.4-1993 Sampling Procedures and Tables for Inspection by Attributes.

5.6.2
Sample testing will normally be completed within 30 days after delivery to the Caltrans Laboratory, barring deficiencies in the shipment, which would reset the clock.

5.6.3
All parameters of the specification may be tested on the shipment sample.

5.6.4
The number of units tested (sample size) shall be determined by the quantity in the shipment. The sample size and acceptance or rejection of the shipment shall conform to ANSI/ASQC Z1.4.

## 6. WARRANTY

Manufacturers shall provide a two (2) year factory-repair warranty for parts and labor on the BBS from date of acceptance by the State. Batteries shall be warranted for full replacement for two (2) years from date of purchase. The warranty shall be included in the total bid price of the BBS.

# Battery Back Up System (BBS) Block Diagram

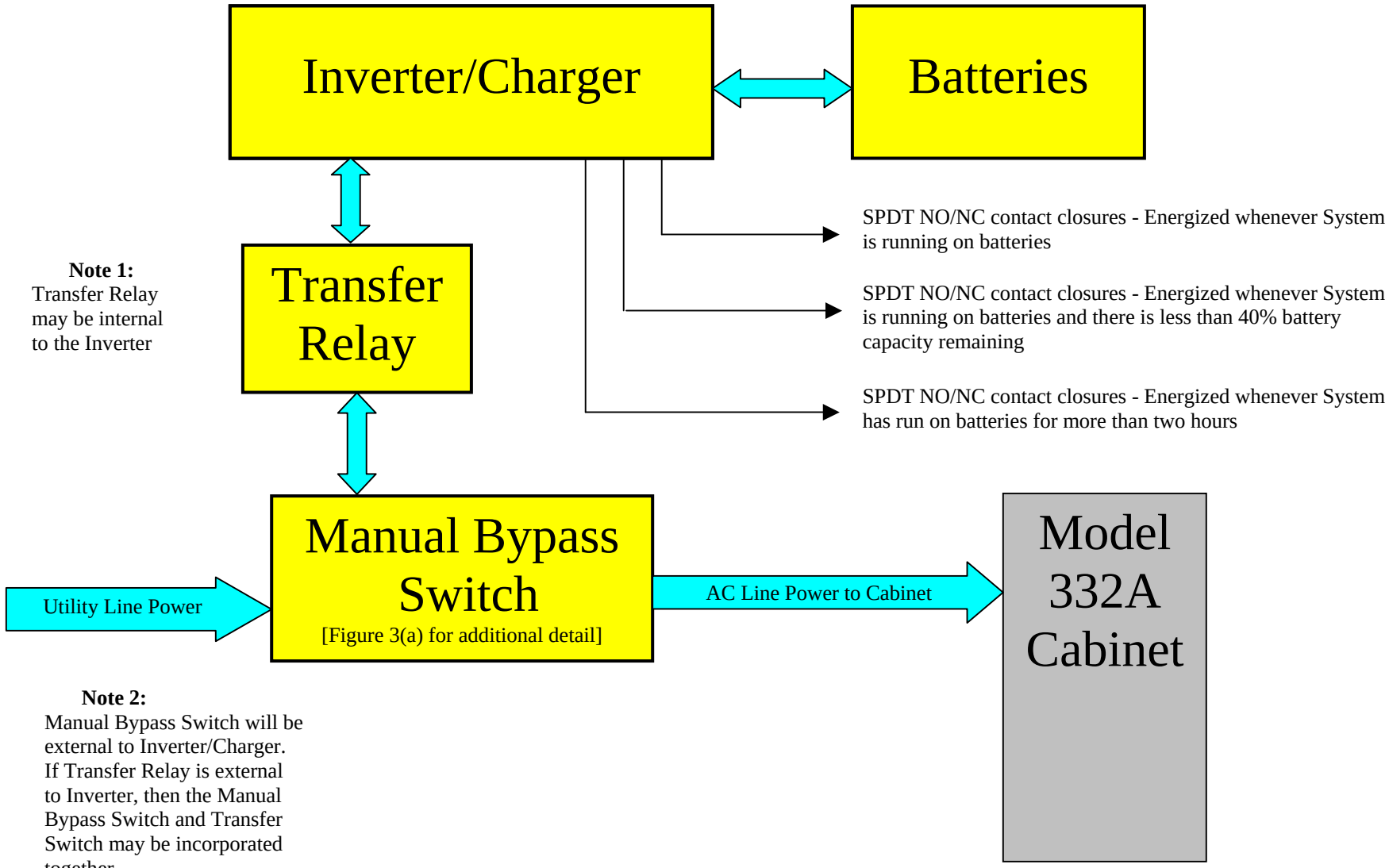
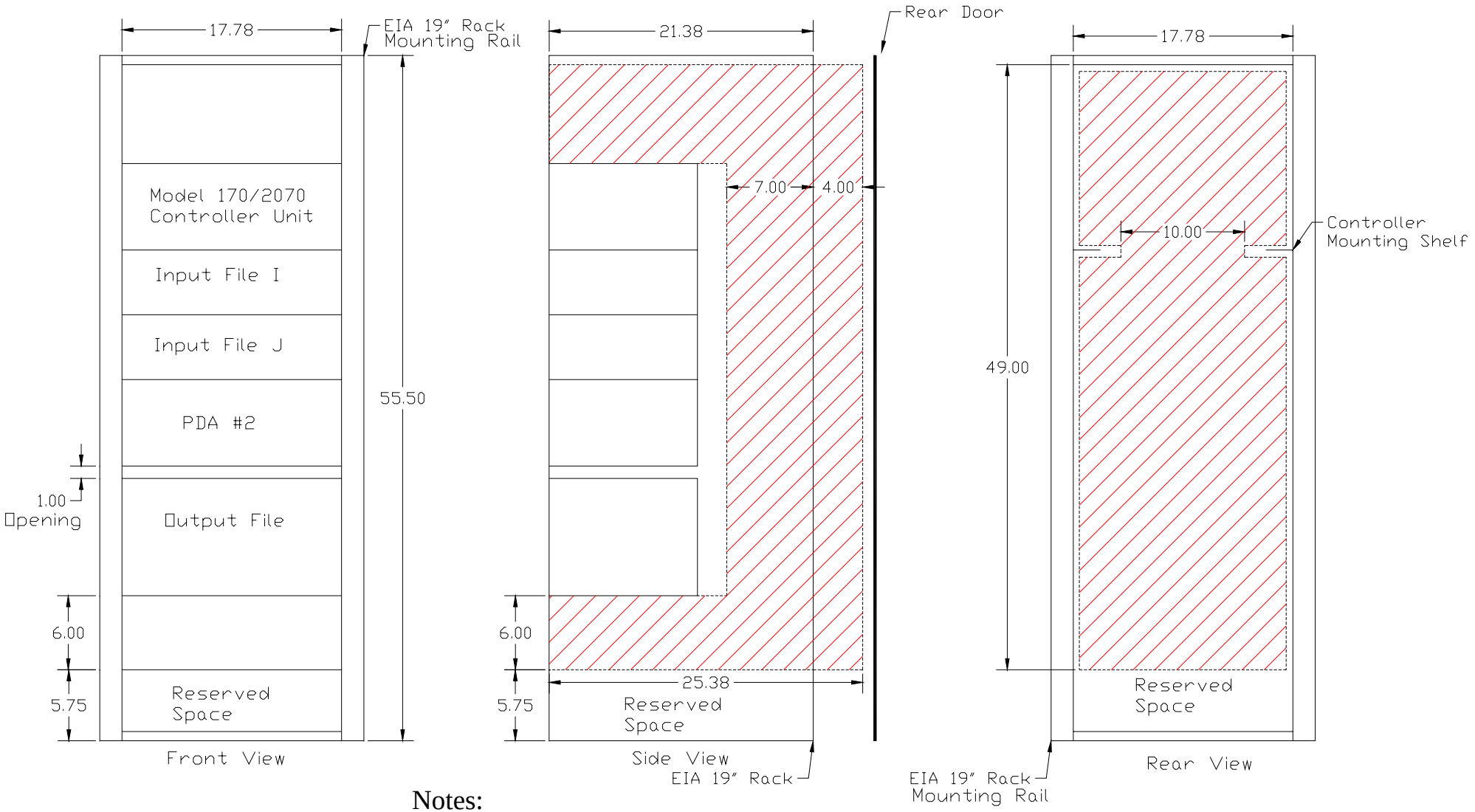



Figure 1

# BBS Mounting Diagram

For a typical Model 332A Cabinet



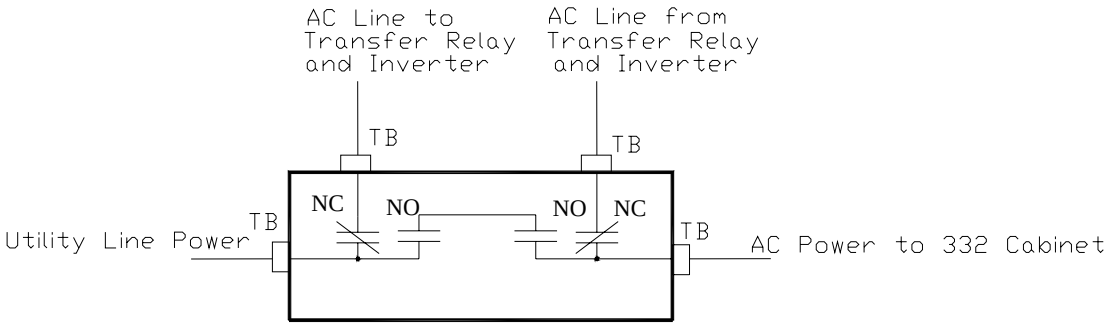

**Notes:**

Area inside of dashed lines represents available mounting locations for BBS.
Prescribed available mounting areas are approximate.
All dimensions shown are in inches.

Figure 2

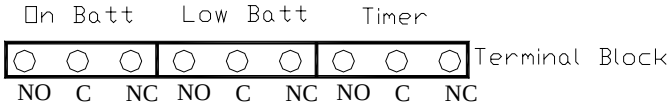
# BBS Specification Clarifications

(a) Manual Bypass Switch (shown in non-bypass, or BBS, mode)




Notes:
1. TB - #8 Terminal Blocks
2. NO - Normally Open
3. NC - Normally Closed
4. NO/NC contacts shall all toggle simultaneously with one single manually operated switch.
5. Manual Bypass Switch shall only switch line. Neutral and Equipment Ground are not switched and shall be connected to 332 Cabinet buses.

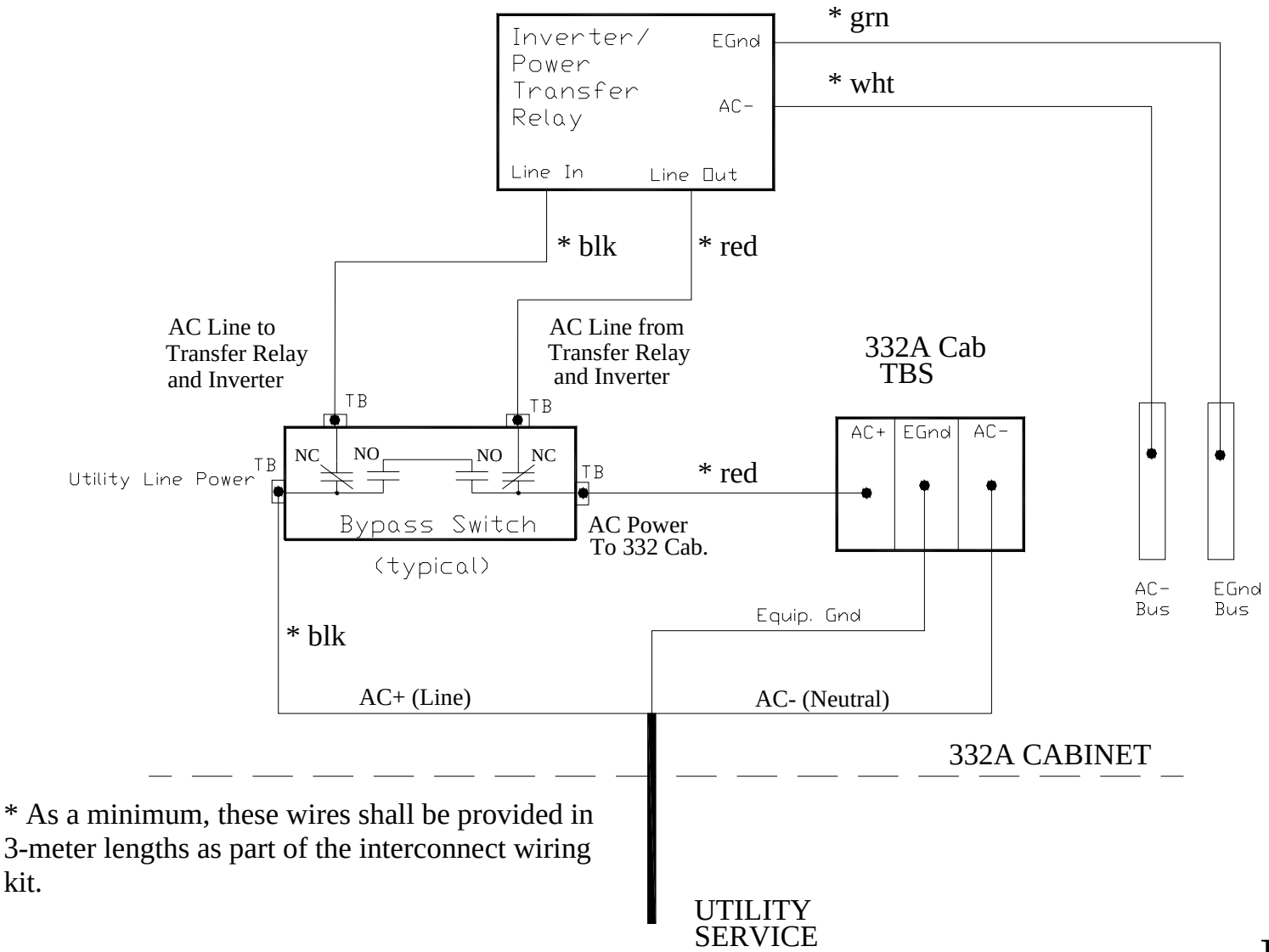
(b) Relay contacts (NO/NC) available on panel-mounted terminal block (typ)




Notes:
1. NO/NC contacts may either share or use separate commons.

Figure 3

# BBS Utility Power Connection Diagram




* As a minimum, these wires shall be provided in 3-meter lengths as part of the interconnect wiring kit.

Figure 4

# External Battery Cabinet

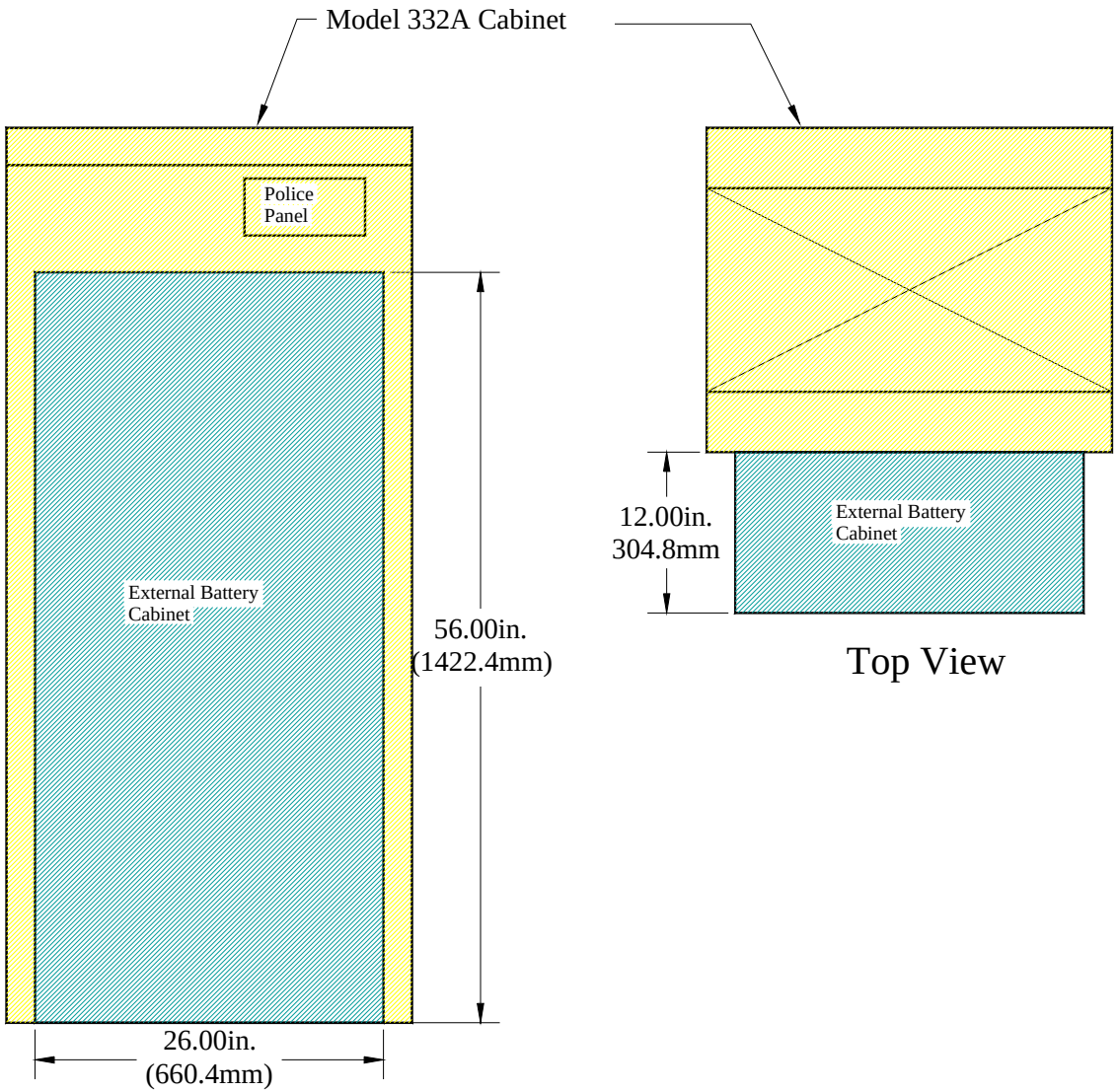
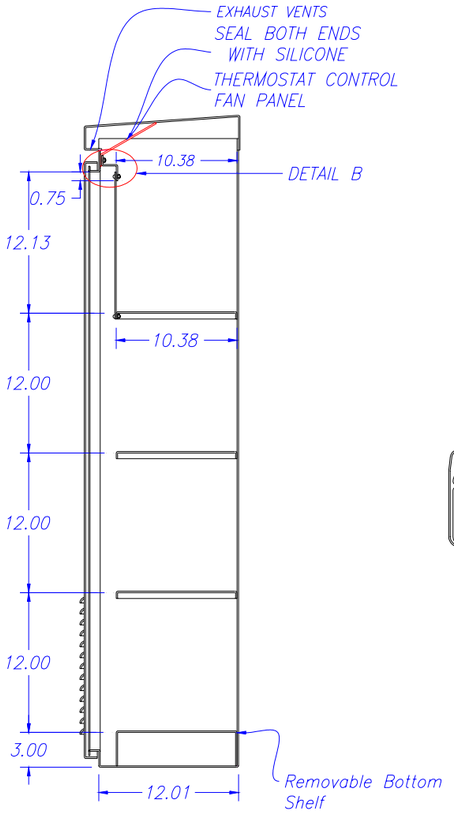
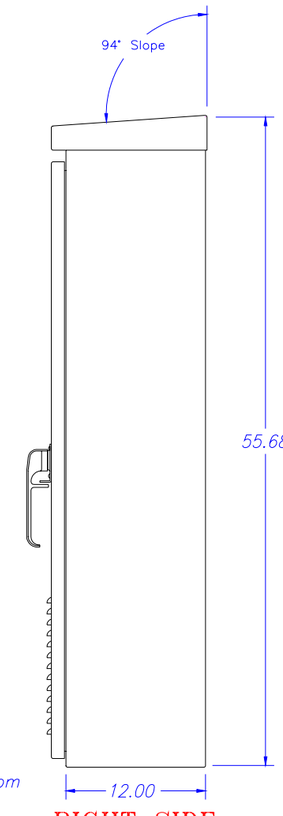


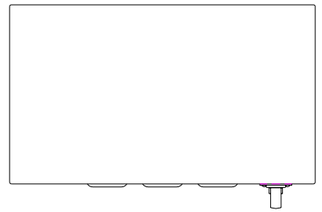

Figure 5



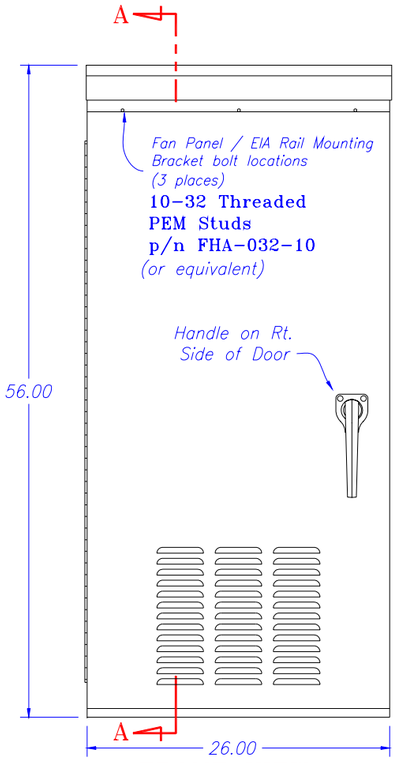

SECTION A-A



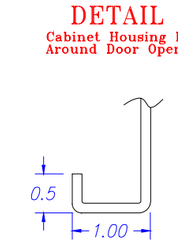

RIGHT SIDE



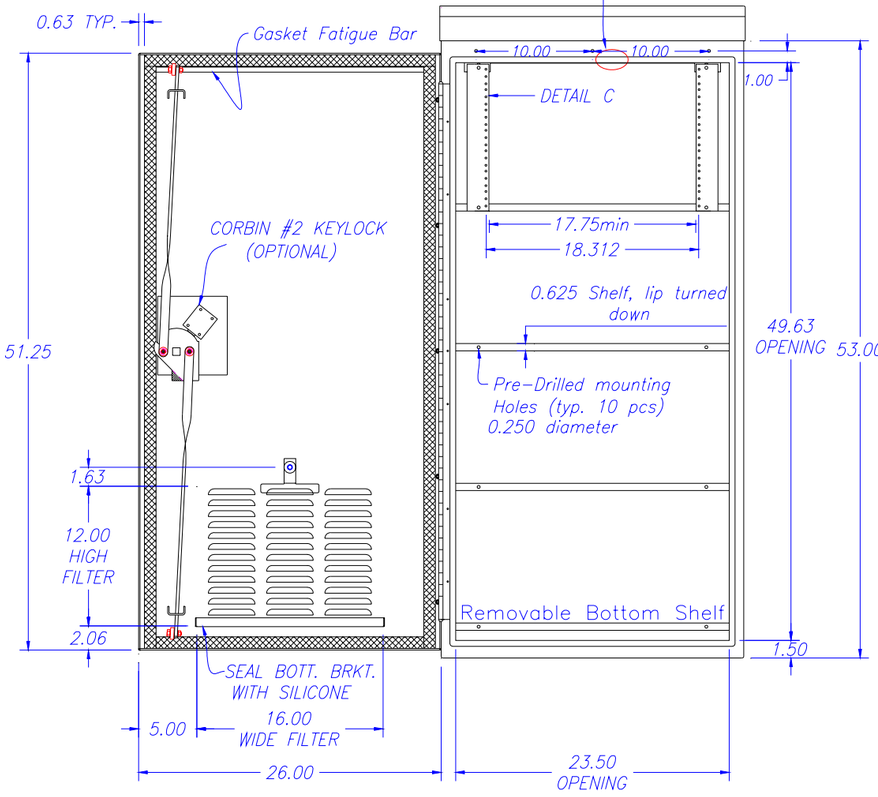
TOP VIEW




FRONT VIEW




DETAIL A
Cabinet Housing Flange
Around Door Opening

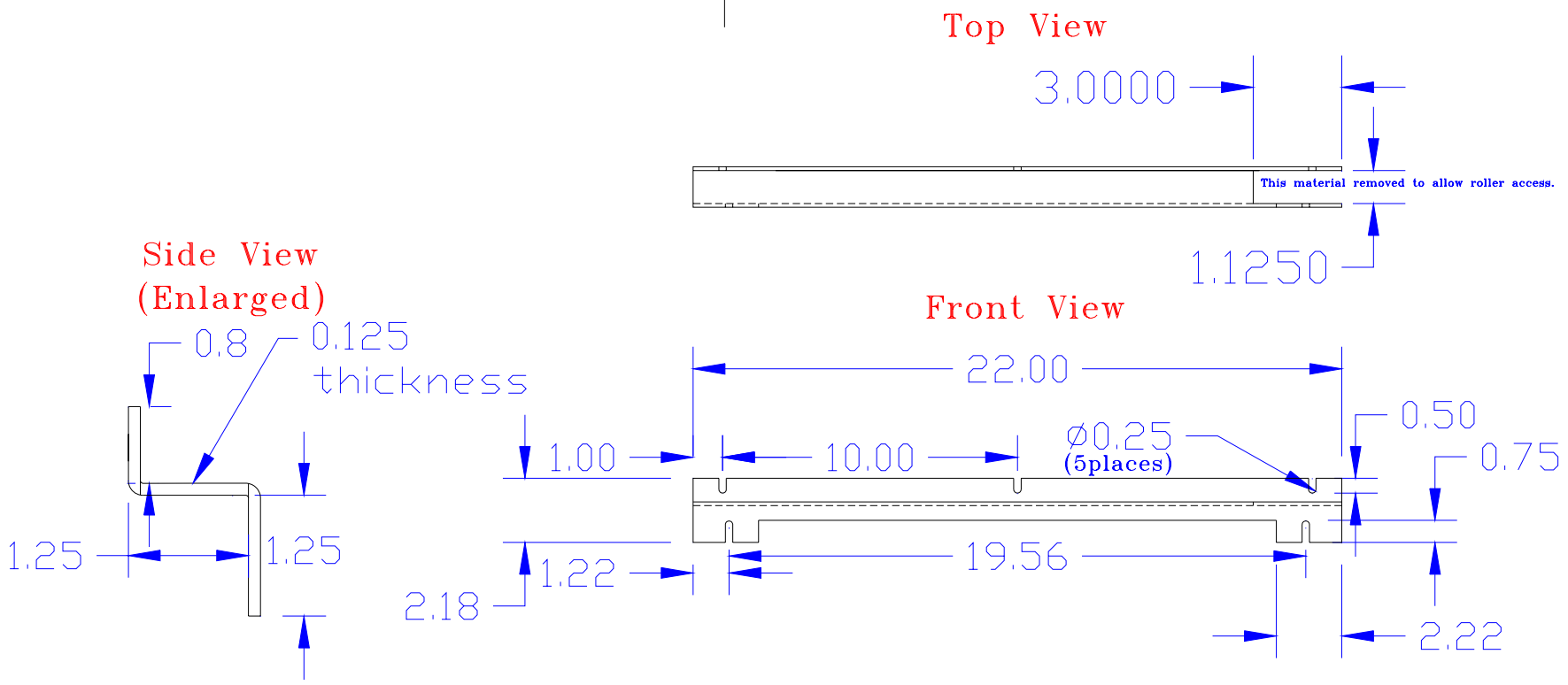



FRONT VIEW
OPEN DOOR

| | | |
|---|---|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES<br>TOLERANCES ARE:<br>FRACTIONS ± 1/16" DECIMALS .XX ± .03 .XXX ± .015 ANGLES ± 1°<br>MATERIAL: .125 ALUM. 5052-H32<br>FINISH: ANODIC COATING: MIL-A-8625C for Type II, Class 1 coatings, with 0.7 mil thickness.<br>DO NOT SCALE DRAWING | ACAD DWG NO. | CALTRANS |
| | APPROVALS / DATES<br>DRAWN 04-09-03<br>CHECKED<br>ISSUED | EXTERNAL BBS CABINET |
| | | SIZE: B · FSCM NO. · DWG. NO. · REV. A<br>SCALE: NONE · SHEET: 1 OF 1 |

Figure 6

| REVISIONS | | | | |
|---|---|---|---|---|
| ZONE | REV | DESCRIPTION | DATE | APPROVED |




Material used shall be 0.125 inch aluminum sheet

CALTRANS

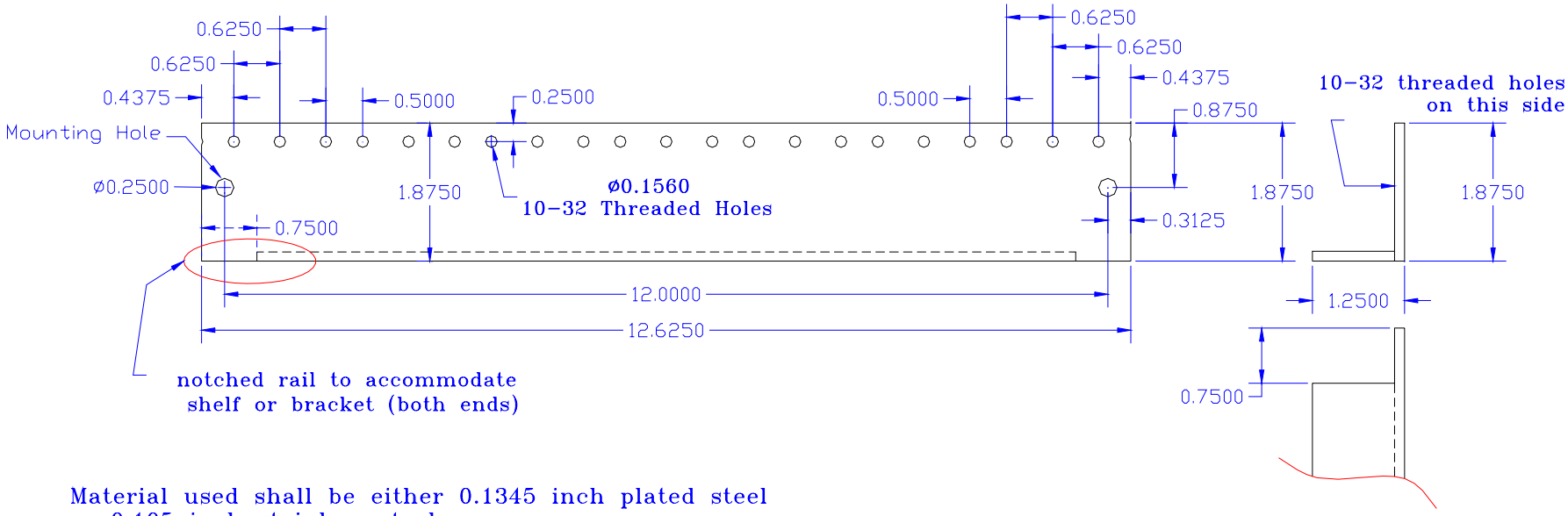
EIA Rail Mounting Bracket. Used to mount EIA rails inside External BBS Cabinet

| DRAWN | SIZE | FSCM NO. | DWG NO. | REV |
|---|---|---|---|---|
| | A | | EIA Angle Bracket Detail B | |
| | SCALE 1:1 | | SHEET Figure 7 | |

| REVISIONS | | | | |
|---|---|---|---|---|
| ZONE | REV | DESCRIPTION | DATE | APPROVED |

# DETAIL C – EIA Angle Rail w/ EIA universal hole spacing

Refer to EIA-310-B




Material used shall be either 0.1345 inch plated steel or 0.105 inch stainless steel.

CALTRANS

EIA rail to be used inside External BBS Cabinet. For mounting inverter or PTR.

| SIZE | FSCM NO. | DWG NO. | REV |
|---|---|---|---|
| A | | EIA Angle Detail C | |

| SCALE | | SHEET |
|---|---|---|
| 1:1 | | Figure 8 |